WHITE PAPER

PRECISION GUIDED MUNITIONS INVESTMENT STRATEGY

APRIL 25, 1995

PREFACE

This paper supports the Air Force position in the FY96 President's Budget Submission and is current as of the day of publication. It has been cleared through Security and Policy review for unlimited release. Due to potential programmatic or budgetary changes, readers should confirm this data prior to use. If this information or additional copies of the paper are required, contact the authors–Lieutenant Colonel Byron Beal, Mr. Steve Adams (The ANSER Corporation), and Mr. Jim Hasik (ANSER)–through the Assistant Secretary of the Air Force (Acquisition), Directorate of Fighter, C2, and Weapons Programs, 1060 Air Force Pentagon, Washington DC 20330-1060.

EXECUTIVE SUMMARY

The Air Force has formulated an investment strategy for precision guided munitions.

The Air Force is committed to precision guided munitions (PGMs) and is making a significant investment in them. PGMs were a key to the quick, decisive victory in Desert Storm and will be a key to winning any future conflict. To guide its PGM investment, the Air Force has formulated a strategy that is driven by external and internal forces –the existing political-military environment and the current Air Force inventory assessment process.

The Air Force's investment strategy is driven by external and internal forces.

The dominant external forces are the fall of the Soviet Union and the rise of well-armed Third World adversaries. The fall of the Soviet Union has caused reduced defense budgets and a decreased emphasis on nuclear weapons. Together these drive the following underlying characteristics of the future force structure:

- A smaller fighter force emphasizing multirole capabilities
- A smaller bomber force emphasizing conventional capabilities
- An overall emphasis on affordability.

With the rise of well-armed, potential Third World adversaries, the Air Force must be able to penetrate increasingly sophisticated air defenses to perform the following missions:

- Neutralize highly defended targets
- Blunt armored spearheads
- Destroy weapons of mass destruction.

The internal forces are the mission deficiencies of the current inventory of guided and unguided weapons, which have undergone only evolutionary, not revolutionary, changes since the Vietnam war.

The Air Force has derived a set of requirements for future weapons.

This combination of internal and external forces provides the basis for the Air Force's future weapon requirements. These requirements emphasize increasing capability on a weapon-by-weapon, aircraft-by-aircraft, and sortie-by-sortie basis. The Air Force's immediate requirements include:

- Accuracy
- Adverse weather capability
- Standoff
- Autonomous guidance
- Multiple kills per pass/multiple targets per release sequence
- Multiaircraft carriage
- Improved hardened target capability
- Affordability.

A limited combination of the future requirements can be met with current weapons.

The Air Force has met limited combinations of these requirements with a series of current generation weapons. These "transitional" weapons meet only a limited number of the future requirements and are being procured in small numbers to meet specific deficiencies:

- **AGM-130**–A modification kit for inventory 2,000-lb bombs that provides precision standoff capability. The kit consists of an electro-optical/imaging infrared (EO/IIR) seeker, a guidance unit featuring a Global Positioning System (GPS)-aided inertial navigation system (INS), and a rocket booster. It is integrated on the F-111 and F-15E and is in full-rate production.
- **AGM-142 HAVE NAP**–A precision standoff hard-target-kill weapon utilizing EO/IIR guidance with a data link, a rocket booster, and an improved penetrator warhead. It is integrated on the B-52.
- **AGM-86C CALCM**–A conventional variant of the nuclear Air-Launched Cruise Missile. A blast-fragmentation warhead has been substituted along with a GPS-aided INS guidance system to give an autonomous, accurate, long-range standoff capability. It is also integrated on the B-52.

The Air Force is developing a next generation of weapons to meet the future requirements.

Due to the limitations of the current weapons, the Air Force is developing a next generation of weapons. Each brings a unique combination of capabilities to the battlefield. This next generation of weapons includes:

- **Sensor Fuzed Weapon**–An unguided antiarmor munition capable of multiple kills per pass. It is currently in low-rate production.
- **Wind Corrected Munitions Dispenser kit**–An Air Force-only program developing an INS guidance kit for existing inventory cluster bombs, including the Sensor Fuzed Weapon. The system will provide an accurate, adverse weather capability.
- **Joint Direct Attack Munition**–A joint Air Force/Navy program developing a low-cost, GPS-aided INS guidance kit for current inventory bombs to provide accurate, adverse weather capability. A product improvement program is being planned with the goal of increasing the system to precision accuracy.
- **Joint Standoff Weapon**–A joint Air Force/Navy program developing a GPS-aided INS-guided glide weapon that will carry various submunitions. The system will provide an accurate, adverse weather, standoff capability.
- **Joint Air-to-Surface Standoff Missile**–A survivable standoff weapon to replace the recently canceled Tri-Service Standoff Attack Missile (TSSAM). Such a capability has long been the centerpiece of the "DoD Joint Standoff Weapons Master Plan." Given the early nature of the program, detailed requirements, other than survivability and standoff, are undefined. Because of the lack of detail, this paper will assume the weapon will have the same basic requirements and capabilities as TSSAM.

Weapons issues must be considered from a larger system perspective.

Because of the considerable capabilities of each of the next generation weapons, there is a tendency to focus simply on the weapon itself. For proper perspective, however, each must be considered as part of a broader weapons system encompassing the launch aircraft and support activities. Some of the issues affecting this larger system are:

- **Combat Capabilities**–When integrated and fielded, the next generation weapons will provide a quantum leap in capability for virtually every combat aircraft. Considered from an operational perspective, these weapons represent a highly effective and affordable mix of warfighting capability. Joint development and procurement with the Navy are further enhancing the cost-effectiveness and utility of this emerging inventory.
- **Aircraft/Weapon Integration**–To achieve their desired result, the next generation PGMs require more data and make more stringent demands on the launch aircraft, greatly increasing the complexity of system integration.
- **Mission Planning**–The next generation weapons require highly accurate target coordinates to achieve their full capability. Enhanced intelligence support and mission planning systems must be fielded along with the new weapons.
- **GPS Vulnerability**–The next generation weapons generally use GPS-aided INS guidance. Concerns have been raised over GPS jamming vulnerability. These weapons have antijam performance commensurate with their requirements–first-strike weapons have higher degrees of immunity, while inventory fill weapons have a lesser degree. However, even in the presence of jamming, the inventory fill weapons are tactically significant.
- **Acceleration of Capability**–The programs currently in development have little opportunity for acceleration. They are either too far along in their development or are already streamlined to provide early capability.
- **Munitions Funding**–The Air Force is preparing to reap the benefits of its substantial investment in weapons development funding. Its commitment to PGMs is demonstrated in the sustained procurement funding extending into the next century. The Air Force, along with OSD and Congress, must continue its support for this funding profile, especially in FY99 and beyond, in order to bring out the revolutionary change in weapon capability.

The Air Force has a vision beyond the weapon programs currently in development.

The current weapons development programs all end near FY00. The next question is "Where does the Air Force go from there?" A promising area of investment appears to be increased lethality from smaller weapons. A smaller, more lethal weapon permits optimal sizing for internal carriage in the next generation of low-observable fighter/attack aircraft and, when coupled with "smart" bomb racks, increases the carriage capacity of current generation aircraft. Overall, the goal of this program would be to develop significantly smaller weapons that allow multiple internal carriage with lethality comparable to current warheads.

The Air Force is committed to fielding a revolutionary generation of precision guided munitions.

In summary, the Air Force has a strategy for the considerable investment it is making in PGMs. The product of that strategy and investment is a revolutionary generation of weapons that will fundamentally change capabilities and thus aerial warfighting. These weapons were developed via a requirements-based process that, in turn, was driven by the changing and uncertain world threat environment, the changes within the Air Force due to the budget realities of the 1990s, and the limitations of the current inventory. The next generation of weapons will provide the warfighter with an unprecedented ability to attack accurately at any time while surviving the hostile environment. However, the weapons cannot be considered in a vacuum. It is the integration of these improved munitions into the entire fighter and bomber force and the development of improved targeting and mission planning capabilities that will bring their full capabilities to bear.

ACRONYMS

AFMSS	Air Force Mission Support System
AGM	Air-to-Ground Missile
ALCM	Air-Launched Cruise Missile
ATACMS	Army Tactical Missile System
BLU	Bombs and Mines, Unit
CALCM	Conventional Air-Launched Cruise Missile
CBU	Cluster Bomb Unit
CEB	Combined Effects Bomblet
CIS	Combat Intelligence System
CISO	Close-In Standoff
DA	Direct Attack
DMA	Defense Mapping Agency
DoD	Department of Defense
DPPDB	Digital Point Positioning Data Base
EO	Electro-Optical
GBU	Guided Bombs, Unit
GPS	Global Positioning System
HARM	High-speed Anti-Radiation Missile
IADS	Integrated Air Defense System
IIR	Imaging Infrared
INS	Inertial Navigation System
JASSM	Joint Air-to-Surface Standoff Missile
JDAM	Joint Direct Attack Munition
JSOW	Joint Standoff Weapon
LGB	Laser-Guided Bomb
MIL	Military
MITL	Man-in-the-Loop
Mk	"Mark"
MRC	Major Regional Conflict
OFP	Operational Flight Program
OSD	Office of the Secretary of Defense
P^3I	Preplanned Product Improvement
PGM	Precision Guided Munition
PIP	Product Improvement Program
PPDB	Point Positioning Data Base
RDT&E	Research, Development, Test, & Engineering
SFW	Sensor Fuzed Weapon
SLAM	Standoff Land Attack Missile
SOAD	Standoff Outside Area Defenses
SOPD	Standoff Outside Point Defenses
SOTD	Standoff Outside Theater Defenses
STD	Standard
TMD	Tactical Munitions Dispenser
TSSAM	Tri-Service Standoff Attack Missile
WCMD	Wind Corrected Munitions Dispenser
WMD	Weapons of Mass Destruction

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Precision Guided Munitions Investment Strategy

INTRODUCTION

The Air Force, as an institution, is committed to precision guided munitions (PGMs) and is making a significant investment in them. PGMs were a key to the quick, decisive victory in Desert Storm and will be a key to winning any future conflict. To guide its investment, the Air Force has formulated a strategy, which this paper outlines. Following a discussion of the external and internal forces that drive the strategy –the existing political-military environment and the current Air Force inventory assessment process –the paper specifies a broad set of characteristics that are the basis of the requirements for the next generation of PGMs. It then narrows its focus to describe next generation weapons and their capabilities. Finally, this paper addresses issues that cut across the boundaries of all the weapon programs and gives a vision for future weapons beyond those currently in development.

EXTERNAL FORCES–EXISTING POLITICAL-MILITARY ENVIRONMENT

For 45 years, the primary military threat for which the United States Air Force prepared was the invasion of Central Europe by the forces of the Soviet Union and its Warsaw Pact allies. The Air Force structured and postured its forces to meet this known threat, relying upon its capabilities to counter other threats as they appeared. However, with the fall of the Soviet Union, the dismantling of the Warsaw Pact, and the ensuing end of the Cold War, several fundamental changes have occurred to the political-military environment.

One of the most predominant changes was, and is, the rapid reduction of the U.S. defense budget. The ability of the Air Force to fulfill its mission –to project Global Reach/Global Power–in the face of this declining budget demands higher effectiveness from the bomber and fighter forces on a weapon-by-weapon, aircraft-by-aircraft, and sortie-by-sortie basis. A second predominant change that came with the decline of the Soviet Union was the simultaneous reduction of the nuclear threat. This enabled a dramatic reduction in the bomber force committed to nuclear deterrence on a daily basis and allowed leveraging bombers' greater range and carriage capability for the conventional role.

Working in combination, the changes caused by the demise of the Soviet Union forced the evolution of the following underlying characteristics of the future Air Force force structure:

- Multirole/Multipurpose Fighters. The changing force structure includes a much smaller fighter force, dominated by the multirole/multipurpose fighter. The Air Force's future weapon systems must take this into consideration by operating more autonomously, reducing the pilot

workload, and providing the fighter force with capabilities once limited only to the special-capability fighters.

- Conventional Bomber Capability. The changing force structure likewise is composed of a much smaller bomber force. While the bomber force has undergone a greater percentage reduction than the fighter force, there is increasing focus on capitalizing on the capabilities, range, and payload of the B-1, B-2, and B-52. In the recent past, conventional weapons were developed, for the most part, only for fighter aircraft. The requirement for bomber compatibility presents a whole new set of challenges for weapon developers. The *Bomber Roadmap* laid out an ambitious plan to equip the bomber force with improved conventional capabilities. Much greater emphasis is now being placed on equipping this force.

- Affordability. The declining defense budget has increased the emphasis on munitions affordability. While low cost does not necessarily equate to affordability, cost is being included as a requirement for some systems – particularly those munitions to be procured in large quantities as inventory fill weapons[1]. This goes hand-in-hand with the emerging importance of the multirole fighter and the renewed emphasis on conventional bomber capability. The Air Force must be able to rapidly develop and procure large quantities of inventory fill weapons for the maximum effectiveness of the entire fleet. Improvements must be made to existing inventory munitions – leveraging the already substantial investment in these systems.

Lastly, focus on regional conflicts has increased, to the extent that national strategy and force structure are now based on the two-major-regional-conflict (MRC) scenario. In the future the United States will likely face a proliferation of well-armed Third World adversaries. The "come-as-you-are" wars of the next 20 years will require the Air Force to respond with a host of capabilities. The allied coalition's 100-hour ground campaign to retake Kuwait dramatically demonstrated the pace of modern combat. Rapidly industrializing, but potentially hostile, nations may seek to dominate adversaries in their regions of the world by rapid ground campaigns to exploit their advantages of proximity and time. As well, 50 years of Cold War have provided a clear example of the deterrent effects of weapons of mass destruction (WMD). Third World powers seeking to dominate their regions of the world are now attempting to master the already mature technologies of atomic energy, chemical/biological weapons, and short-range ballistic missiles. Having witnessed the example of American airpower in the Gulf War, minor powers are increasingly turning to deeply buried, hardened facilities to protect these valuable national military assets. Finally, sales of integrated air defense systems (IADS) around the world have increased the densities of threats that allied aviators might have once faced only in Central Europe. Arching over both advancing ground forces and home-based WMD, these IADS will challenge the Air Force's ability to prosecute air campaigns and thus the United States' leverage in regional

[1]"Inventory fill" weapons, also known as "level of effort" weapons, are those whose inventory requirements are calculated within the constraints of sortie generation and expected conflict duration. "Estimating Conventional Munitions Requirements: Toward Improved Processes," Kassing et al., (RAND, Santa Monica: 1991).

conflicts. Responding to the scene, Air Force squadrons will need to complete several daunting tasks simultaneously:

- Neutralize highly defended targets from the start of hostilities before enemy defenses are rolled back
- Blunt enemy armored spearheads and saturate target complexes
- Penetrate heavily fortified targets to destroy adversarial capacity for mass destruction.

In summary, the changing political-military environment with the decline of the Soviet Union has resulted in reduced defense budgets and force structures. These, in turn, have driven an emphasis on multirole fighters, the bomber force, and affordability. Additionally, a proliferation of potential Third World adversaries requires the Air Force to be able to respond rapidly with decisive airpower.

INTERNAL FORCES–CURRENT AIR FORCE INVENTORY ASSESSMENT

The Air Force procures its weaponry via a requirements-based process. The requirements for this process are generated based on mission deficiencies versus a particular threat. Much of the current Air Force capability originates from a global Cold War strategy and threat. The Air Force's overwhelming success in Desert Storm demonstrated the effectiveness of this Cold War force. However, the Air Force inventory, as well as the technologies that it is based on, has remained fundamentally unchanged since the end of the Vietnam war. The limitations of the current inventory and its technologies were also shown in Desert Storm. The current weapons are categorized in Figure 1.

Figure 1: Current Air Force Inventory Munitions[2]

	Direct Attack (DA)	Close-In Standoff (CISO)	Standoff Outside Point Defenses (SOPD)	Standoff Outside Area Defenses (SOAD)	Standoff Outside Theater Defenses (SOTD)
Unguided	General Purpose (GP) Bombs Cluster Bombs (CBUs)				
Guided	GBU-10/-12 AGM-65A/B	GBU-15 GBU-24/-27/-28 AGM-65D/G	AGM-88 AGM-130 AGM-142		AGM-86C

Note: Weapons are listed in order by standoff range in accordance with the definitions in the "DoD Joint Standoff Weapons Master Plan." Actual mileage definitions are classified.

In terms of quantity, the inventory is dominated by unguided free-fall munitions – general purpose bombs (Mk-82/-84/-117) and various cluster bombs (CBU-87/-89 and the

[2]"DoD Joint Standoff Weapons Master Plan," 31 March 1994, p. 3-1.

older CBU-52/-58/-71 and Mk-20 Rockeye). While these munitions can be quite effective, much can be done to improve them–most notably in terms of their accuracy.

Since General Mitchell's experiments in the 1920s, the Air Force has sought dominance of warfare through aerial bombardment. Despite a long evolution, this goal remained unfulfilled for years. For example, during the Second World War, the destruction of the German ball bearing plant at Schweinfurt required 228 B-17 *Flying Fortress* sorties carrying over 483 tons of bombs.[3] Despite the technological advances of the next 20 years, the Air Force's ability to destroy targets changed only incrementally. In late 1966 and early 1967, the destruction of the Paul Doumer Bridge in Hanoi, North Vietnam, required 113 sorties by F-105 *Thunderchief* aircraft carrying 380 tons of bombs.[4] Until the advent of PGMs, only two methods sufficed for increasing the probability of destroying an enemy target: sending bigger aircraft with more bombs or sending more aircraft with more bombs. The promise for the future was shown during the Easter Offensive of 1972 when sixteen F-4 *Phantoms* destroyed the same rebuilt bridge on a single mission with just 29 tons of laser and electro-optically (EO) guided bombs.[5] Notwithstanding the leverage they represented for aerial bombardment, PGM technology remained largely unchanged for the following 20 years as the Air Force inventory underwent only incremental improvements. Despite the dramatic television footage of weapons entering ventilation shafts and tanks destroyed by high-altitude bombardment, only 6.7% (9,494) of air-to-surface weapons dropped during the Gulf War were PGMs.[6] Intelligent aircraft systems provided relative accuracy to the other 210,000 air-to-surface munitions, but often the equipment and sites targeted on these missions required multiple aircraft sorties for destruction.

During the Cold War, much of the weapons development effort was directed at low-altitude delivery to provide a sanctuary from the medium- and high-altitude defenses of the Warsaw Pact. Experiences in Desert Storm, as well as the planned increased conventional role for bombers, have highlighted the need for better accuracy when the weapons are delivered from medium and high altitudes. The effects of wind and other factors on the ballistics of these free-fall munitions must be compensated for. In the next war, dropping large quantities of inaccurate, unguided weapons will result in ineffective sorties that will needlessly hazard aircraft and prolong the conflict. Rapid, surgical response with a diminished force structure will require that every sortie and every weapon count. By improving the accuracy of these existing munitions, a force multiplier effect is achieved for the entire force structure.

The majority of the current inventory PGM capability is provided by the fighter force using LGBs, the GBU-10/-12/-24/-27/-28. Fighters can also employ the EO/imaging infrared (IIR)-guided GBU-15, AGM-130, and AGM-65 *Maverick*. The bomber force's PGMs, the

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[3]*The United States Strategic Bombing Survey, Summary Report (European War),* (Washington, DC: War Department, 1945); and *The United States Army Air Forces in World War II, Vol. 2: Torch to Pointblank*, W. F. Graver & D. L. Cates, Ed., (Washington, DC: Department of the Air Force, 1949), p. 703.

[4]*The Tale of Two Bridges* (USAF Southeast Asia Monograph #1), Colonel Delbert Corum, USAF, et al., (Washington, DC: Department of the Air Force, 1976), pp. 67-77.

[5]Corum, op. cit., pp. 88-92; and "Paul Doumer Bridge: A Study of Leadership," Major T. J. Myers, ANG (unpublished paper, Air Command and Staff College, Maxwell AFB, AL, 1986), pp. 7-11.

[6]*The Gulf War Air Power Survey*, Elliot Cohen, Ed., (Washington, DC: Department of the Air Force, 1993), p. 553, table 191. This figure is derived by dividing the sum of the number of guided weapons in the tables of ordnance expended by the sum of the numbers of guided and unguided weapons.

AGM-86C Conventional Air-Launched Cruise Missile (CALCM) and AGM-142 HAVE NAP, have increased standoff capabilities but have been procured in very limited numbers and integrated only on the B-52. Despite its proven capabilities, the current PGM inventory is not without its deficiencies.

The most glaring deficiency of the current PGM inventory is its lack of adverse weather capability. The employment of each of these weapons, except for CALCM, is limited during adverse weather, e.g., rain, fog, and low cloud ceilings. This significantly impacts the Air Force's ability to prosecute an air campaign. Even though the littorals of the Persian Gulf normally offered relatively clear skies year round, the air campaign of Desert Storm suffered from debilitating weather conditions. By the tenth day of the air war, attrition of Iraqi defenses had only progressed to the point expected by the campaign's planners by the fourth or fifth day. In combat on the Korean Peninsula in February, conditions would undoubtedly be worse.

The second most critical deficiency of the current PGM inventory is range. Constrained by the limited range of some weapons, aircrews may have to penetrate the lethal range of enemy air defenses to deliver the weapons. In reality, this deficiency applies equally to the unguided inventory, which is entirely composed of direct attack weapons. This limitation risks not only each particular mission's success, but also the individual aircrews and aircraft and the warfighting commander's overall ability to prosecute the conflict. This risk has been overcome to some extent by development of specialized aircraft –the F-117 and B-2 for stealth delivery and the F-4G and EF-111 for suppression of enemy air defenses. In the future, though, the Air Force will have fewer specialized aircraft. Bombers and fighters must be able to destroy targets without entering the lethal range of surface-to-air defenses.

The current generation of guided munitions is also limited by its reliance on man-in-the-loop (MITL) methods of target acquisition (as in the AGM-65) or guidance (as in the laser designator for LGBs or data links for the GBU-15, AGM-130, and HAVE NAP). MITL for target acquisition generally forces shorter launch ranges and, again, may put the aircraft in the lethal range of air defenses. Reliance on MITL guidance generally requires specialized mission aircraft and specially trained aircrews, limiting weapon employment.

Again, despite their considerable capabilities, the current generation weapons have deficiencies in the areas of accuracy, adverse weather capability, range, and MITL guidance. As defense budgets drive the Air Force to a future force structure emphasizing single seat, multirole fighters, these weapons may limit that force's effectiveness.

REQUIREMENTS FOR FUTURE WEAPONS

The existing political-military environment and current munitions limitations provide the basis for many of the Air Force's munitions requirements. In an uncertain future, with an ill-defined threat and a diminishing force structure, every aircraft sortie must count. The munitions of the future must enable warfighters to effectively accomplish their mission –and survive to fight again another day. The Air Force's immediate requirements include:

- Accuracy. Derives directly from the accuracy limitation of the extensive unguided inventory and the need to improve warhead effectiveness on a

sortie-by-sortie, weapon-by-weapon basis. Additionally, increased accuracy provides benefits by reducing collateral damage and civilian casualties. This will be especially important for peacekeeping operations where combatants and noncombatants are frequently in close proximity. Improved accuracy for munitions provides a force multiplier effect –which enhances the effectiveness and efficiency of the entire force structure.

- Adverse Weather Capability. Derives from the limitations of current PGMs. The Air Force must be able to take out those high-value, time-critical targets at the time of its own choosing. In this case, adverse weather includes natural or man-made effects such as rain, haze, dust, smoke, fog, and/or clouds. For enemy forces to be quickly and decisively defeated, they cannot be allowed the sanctuary of weather to evade air power.

- Standoff. Derives from the range deficiency of the majority of current PGMs and all unguided munitions. Standoff weapons enable aircraft to strike high value targets while surviving air defenses, and they can themselves destroy those air defenses permitting follow-on aircraft to strike targets with less expensive direct attack weapons. Implicit to standoff is survivability–the ability of the weapon itself to survive to complete its mission. Standoff is also required to extend the theater commander's area of influence beyond the combat radius of his aircraft, enhancing his flexibility in basing, mission routing, and attack options.

- Autonomous Guidance. Derives from the night/weather limitations of current MITL guidance systems and the need to limit the number of specialized aircraft. Autonomous weapons reduce the pilot workload of multirole fighters and enable launching larger numbers of weapons from the bombers where MITL guidance makes multiple launches difficult. Autonomous weapons therefore increase the effectiveness of each mission.

- Multiple Kills Per Pass/Multiple Targets Per Release Sequence. Multiple kills per pass is defined as a weapon independently detecting and destroying multiple targets following release from an aircraft, while multiple targets per release sequence is defined as multiple, independently targeted weapons being released per pass. Even though they are slightly different in definition, both achieve the same outcome, and both derive from the need to maximize the effectiveness of sorties and to reduce the risk to aircraft through repeated exposures. The Air Force must be able to effectively attack more than one target on each pass.

- Multiaircraft Carriage. Derives from the increased emphasis on the use of multirole aircraft and the conventional role of the bomber force. Additionally, the bomber force provides a tremendous resource to rapidly

apply air power anywhere in the world through long-range, endurance, and large-payload capability.

- Improved Hardened Target Penetration. Derives from the proliferation of hardened targets throughout the world, especially the Third World. The extent of hardening is far greater than previously realized. Experiences in Desert Storm reemphasized the need for improvements in this capability. High-value targets, such as C^3I nodes, will be protected through hardening and dedicated defenses. These targets are important to the enemy as well as us. The enemy cannot be given this sanctuary. This requirement is also being emphasized as the DoD looks more closely at counterproliferation.

- Affordability. Derives from the pressures of the decreasing defense budget. As the Air Force makes improvements to its munitions capability in today's budgetary environment, it must seek low-cost options. The need and the ability–through technology--exist to improve the capabilities of all weapons, including the inventory fill weapons purchased in large quantities. For example, competition or incorporation of new acquisition strategies reduces weapon costs. For improved weapons to be affordable in the quantities needed to fulfill worldwide obligations, their costs must be contained. It is not that the Air Force cannot afford high-cost, high-capability weapons. Rather, the appropriate mix must provide warfighters with the munitions they need.

These are not all the Air Force's weapon requirements, but those being addressed immediately with current programs. These requirements will not be met by a single weapon system, but by a set of weapons that will provide the warfighting commanders the flexibility needed to accomplish their mission.

NEXT GENERATION WEAPONS

The Air Force has met limited combinations of the future requirements with a series of current generation weapons: the AGM-130, the AGM-86C CALCM, and the AGM-142 HAVE NAP. However, these "transitional" weapons meet only a limited number of the future requirements. Accordingly, the Air Force is developing a next generation of weapons. This next generation of weapons includes: the Sensor Fuzed Weapon (SFW), the Wind Corrected Munitions Dispenser (WCMD) kit, the Joint Direct Attack Munition (JDAM), the Joint Standoff Weapon (JSOW), and the Joint Air-to-Surface Standoff Missile (JASSM), the replacement for the recently canceled Tri-Service Standoff Attack Missile (TSSAM). Each brings a unique combination of capabilities that meet portions of the list of future requirements.

The AGM-130 integrates an EO/IIR seeker, guidance unit, data link, and rocket motor onto inventory Mk-84 and BLU-109 2,000-lb. warheads. It currently provides a precision standoff hard-target-kill capability. When integrated with a Global Positioning System

(GPS)-aided inertial navigation system (INS), it will provide limited adverse weather capability. HAVE NAP utilizes EO/IIR guidance with a data link to provide precision accuracy, a rocket booster for standoff, and an improved penetrator warhead for hard-target-kill capability. CALCM is a conventional variant of the nuclear Air-Launched Cruise Missile. A blast-fragmentation warhead has been substituted along with a GPS-aided guidance system to give an autonomous, accurate, long-range standoff capability. The HAVE NAP and CALCM are integrated only on the B-52. These weapons–the AGM-130, HAVE NAP, and CALCM–are current generation because they bear the limitations of the current generation PGMs, e.g., MITL guidance and/or limited aircraft carriage. Accordingly, they have been procured in limited numbers. However, they are important because they bring a degree of next generation combat capabilities, e.g., standoff, precision, and hard-target-kill. These weapons now carry greater importance due to the recent cancellation of TSSAM. They will provide the interim solution to bridge the capabilities shortfall until JASSM is developed and fielded.

The SFW is an antiarmor munition and is the latest addition to the Tactical Munitions Dispenser (TMD) family of cluster munitions. Although it is already in production and is unguided, it is included in the next generation because it introduces the first smart submunition, the BLU-108, into the inventory. This program has demonstrated its effectiveness through extensive testing and will provide a much needed multiple-kills-per-pass capability against armored forces.

The WCMD is an INS guidance kit developed for the TMD family of cluster munitions: the CBU-87 Combined Effects Munition, the CBU-89 Gator, and the CBU-97 SFW. The WCMD kit will improve the accuracy of this dispenser when delivered from medium and high altitude. The acquisition program is using streamlined practices to shorten development time and to reduce costs.

The JDAM is a joint Air Force/Navy program with the Air Force as lead Service. The JDAM program is developing a low-cost GPS-aided INS kit for the Air Force inventory of Mk-84 and BLU-109 2,000-lb and Mk-83 1,000-lb bombs. JDAM will provide an accurate, all-weather capability for virtually the entire bomber and fighter force (for the Navy as well). JDAM is a DoD Acquisition Reform Pilot Program that is looking at commercial practices and other means to streamline the acquisition process. Through the regulatory and statutory relief provided by the Pilot Program status, JDAM hopes to expedite the acquisition process for substantial cost savings. Also, future improvements to JDAM will be developed under the JDAM Product Improvement Program (PIP), the foremost of these being improved accuracy.

The JSOW is another joint Air Force/Navy program, with the Navy as lead Service. JSOW will provide an accurate standoff dispenser capability. The first, or baseline, version includes GPS-aided INS guidance and the BLU-97 Combined Effects Bomblet (CEB) from the CBU-87. The Air Force is also integrating the BLU-108, the SFW smart submunition, into a standoff antiarmor variant. The CEB variant will be developed and procured first, with Air Force procurement of the BLU-108 variant beginning after FY00.

The JASSM is the follow-on program for TSSAM. TSSAM had long been the centerpiece of the "DoD Joint Standoff Weapons Master Plan," fulfilling the need for a stealthy standoff weapon with a precision hard-target-kill capability. Due to long delays in development, continuing technical difficulties, and increasing costs, the Secretary of Defense recently terminated the TSSAM program. However, the Air Force still has the requirement

for a standoff weapon to hold heavily defended, high-value targets at risk. To fulfill that requirement, planning for the JASSM program began immediately after TSSAM's cancellation. Given the early nature of the JASSM program, detailed requirements, other than to be a survivable standoff missile, are undefined. This paper will assume JASSM will have the same basic requirements and capabilities as TSSAM.

Figure 2 summarizes the next generation of weapons and their capabilities. These weapons meet the broad requirements for future weapons.

Figure 2: Next Generation Weapons Capabilities

	Accuracy	Adverse Weather	Standoff	Autonomous Guidance	Multi Kills Per Pass/ Multi Tgts Per Release	Multi Aircraft Carriage	Hard Target Capability
AGM-86C	Accurate	X	SOTD	X	X		
AGM-130	Precise	Limited	SOPD	Limited			X
AGM-142	Precise	Limited	SOPD	Limited			X
SFW					X	X	
WCMD	Accurate	X		X	X	X	
JDAM	Accurate	X	CISO	X	X	X	X
JDAM PIP	Precise	X	CISO	X	X	X	X
JSOW	Accurate	X	SOPD	X	X	X	
JASSM	Precise	X	SOAD	X	X	X	X

Note: Transitional weapons are listed in underlined GREEN, and next generation weapons in *italicized BLUE*.

WEAPONS ISSUES

Because of the considerable capabilities of each of the next generation weapons, there is a tendency to focus simply on the weapon itself. For proper perspective, however, each must be considered as part of a broader system encompassing the launch aircraft and weapons support activities. For example, many of these munitions will provide an autonomous, adverse weather capability. But this autonomous capability comes with a price. Targeting and mission planning capabilities must also keep pace. At the core of much of this autonomous capability is the GPS system. This satellite navigation system provides the potential for significant accuracy improvements for virtually all weapons, and at a fairly low cost. The GPS constellation is in place and has worldwide coverage capability. However, the Air Force must be cautious in relying solely on GPS for all guidance solutions. GPS has vulnerabilities. These issues and others will be expanded upon in the following subsections.

Combat Capabilities

When considering combat capabilities, the first question to be considered is "Why is the Air Force procuring multiple weapons that appear to have the same basic capabilities?" For example, why does the Air Force need JDAM and JASSM that both have a hard-target-kill capability; likewise, why does it need WCMD and JSOW to deliver submunitions against area targets? From the perspective of number of weapon types versus number of target types, it might appear that more weapons than required are being developed and procured. However, that approach is simplistic: it ignores operational factors in servicing a target set such as employment doctrine and threat. For example, consider JDAM and JASSM versus hard, fixed targets. JDAM is an inventory fill direct attack weapon to be used after rollback of enemy air defenses. It has a low unit cost requirement to permit it to be procured in the large quantities required to service large numbers of targets. The JASSM, on the other hand, will be developed to destroy highly defended, high-value targets. It will require standoff and survivability to complete its mission and, consequently, will be higher in cost and procured in lesser numbers. JASSM and JDAM have similarities but are not redundant or duplicative. Each brings unique capabilities and operational flexibility to the warfighter. Having multiple weapons to engage a target set does not necessarily imply duplication and redundancy in weapon development.

With regard to operational factors, the best measure is the overall warfighting capability the next generation weapons will provide. Figure 3 shows the capability that Air Force aircraft have with current inventory weapons. Despite the tremendous demonstration of capability in Desert Storm, there are obviously numerous capability gaps. Furthermore, much of the Air Force's current PGM capability is clumped within a few aircraft. However, after the next generation of weapons has been completely integrated into the Air Force inventory in the FY05 timeframe, the bomber and fighter force will have the considerable mix of capability demonstrated in Figure 4. The matrix is virtually completely populated, showing the aircraft-by-aircraft leap in capability.

The last measure of the combat capability that these weapons will bring is the increased effectiveness of joint development and fielding. Of the five next generation weapons programs, three–JDAM, JSOW, and JASSM–are joint programs with the Navy. Additionally, the BLU-108 submunition in SFW is also being integrated into a JSOW variant. Therefore, the capabilities of these weapons will not be uniquely Air Force capabilities. They will be capabilities that the warfighting Commanders-in-Chief can expect from all segments of their air components.

Figure 3: Current Aircraft/Weapons Capabilities

	Accuracy		Adverse Weather	Standoff			Hard Target Kill Capability	Multi Kills Per Pass/ Multi Kills Per Release
	Precise	Accurate		CISO	SOPD	SOAD/ SOTD		
B-1								
B-2								
B-52	AGM-142	AGM-86C	AGM-86C AGM-142 (Limited)		AGM-142	AGM-86C	AGM-142	AGM-86C
F-16C Blk 40	GBU-10/-12 GBU-24 AGM-65			GBU-24 AGM-65D/G			GBU-24 AGM-65	
F-16C Blk 50	AGM-65			AGM-65D/G	AGM-88		AGM-65	AGM-88
F-15E	GBU-10/-12 GBU-24/-28 AGM-65 GBU-15 AGM-130		AGM-130 (Limited)	GBU-24 GBU-28 AGM-65D/G GBU-15	AGM-130		GBU-24 GBU-28 AGM-65 GBU-15 AGM-130	
F-111	GBU-10/-12 GBU-24/-28 GBU-15 AGM-130		AGM-130 (Limited)	GBU-24 GBU-28 GBU-15	AGM-130		GBU-24 GBU-28 GBU-15 AGM-130	
F-117	GBU-27			GBU-27			GBU-27	
F-22								

Notes: 1. Current generation weapons are listed in BLACK, and transitional weapons in **underlined GREEN**.
2. The GBU-28 provides a very-hard-target-kill capability on the F-15E and F-111.

Figure 4: Current and Future Aircraft/Weapons Capabilities

	Accuracy		Adverse Weather	Standoff			Hard Target Kill Capability	Multi Kills Per Pass/ Multi Kills Per Release
	Precise	Accurate		CISO	SOPD	SOAD/ SOTD		
B-1	*JDAM PIP JASSM*	*JDAM JSOW WCMD*	*JDAM (PIP) JSOW WCMD JASSM*	*JDAM (PIP)*	*JSOW*	*JASSM*	*JDAM (PIP) JASSM*	*SFW JDAM (PIP) JSOW WCMD JASSM*
B-2	*JDAM PIP JASSM*	*JDAM*	*JDAM (PIP) JASSM*	*JDAM (PIP)*		*JASSM*	*JDAM (PIP) JASSM*	*SFW JDAM (PIP) JASSM*
B-52	**AGM-142** *JDAM PIP JASSM*	**AGM-86C** *JDAM JSOW WCMD*	**AGM-86C AGM-142 (Limited)** *JDAM (PIP) JSOW WCMD JASSM*	*JDAM (PIP)*	**AGM-142** *JSOW*	**AGM-86C** *JASSM*	**AGM-142** *JDAM (PIP) JASSM*	**AGM-86C** *SFW JDAM (PIP) JSOW WCMD JASSM*
F-16C Blk 40	**GBU-10/-12 GBU-24 AGM-65** *JDAM PIP JASSM*	*JDAM JSOW WCMD*	*JDAM (PIP) JSOW WCMD JASSM*	**GBU-24 AGM-65D/G** *JDAM (PIP)*	*JSOW*	*JASSM*	**GBU-24 AGM-65** *JDAM (PIP) JASSM*	*SFW JDAM (PIP) JSOW WCMD JASSM*
F-16C Blk 50	**AGM-65** *JDAM PIP JASSM*	*JDAM JSOW WCMD*	*JDAM (PIP) JSOW WCMD JASSM*	**AGM-65D/G** *JDAM (PIP)*	**AGM-88** *JSOW*	*JASSM*	**AGM-65** *JDAM (PIP) JASSM*	**AGM-88** *SFW JDAM (PIP) JSOW WCMD JASSM*
F-15E	**GBU-10/-12 GBU-24/-28 AGM-65 GBU-15 AGM-130** *JDAM PIP JASSM*	JDAM JSOW WCMD	**AGM-130 (Limited)** *JDAM (PIP) JSOW WCMD JASSM*	**GBU-24 GBU-28 AGM-65D/G GBU-15** *JDAM (PIP)*	**AGM-130** *JSOW*	*JASSM*	**GBU-24 GBU-28 AGM-65 GBU-15 AGM-130** *JDAM (PIP) JASSM*	*SFW JDAM (PIP) JSOW WCMD JASSM*
F-117	**GBU-27** *JDAM PIP*	*JDAM*	*JDAM (PIP)*	**GBU-27** *JDAM (PIP)*			**GBU-27** *JDAM (PIP)*	JDAM (PIP)
F-22		*JDAM*	*JDAM*	*JDAM*				*JDAM*

Notes:
1. Current generation weapons are shown in BLACK, transitional weapons in **underlined GREEN**, and next generation weapons in *italicized BLUE*.
2. The GBU-28 provides a very-hard-target-kill capability on the F-15E.
3. The F-111 is programmed to retire starting in FY96 and will not receive the next generation weapons. Therefore, it is not shown on this chart.

Aircraft/Weapon Integration

For all its added capability, the next generation of PGMs also brings an increased level of complexity to aircraft integration by placing more stringent data demands on the launch aircraft. For example, inventory LGBs require no communication with the aircraft prior to launch. Integration consists of confirming the physical fit and separation and incorporation of the correct ballistics into the aircraft operational flight program (OFP). To attain the desired level of performance, the next generation of PGMs requires information such as precise targeting data, GPS ephemerides and cryptokeys, GPS-quality launch coordinates, and an INS transfer alignment. This aircraft-weapon communication requires an extensive, and expensive, aircraft OFP software development and test effort across multiple aircraft. Further, not all aircraft have the MIL-STD-1760 interface architecture. Without this standardized interface, aircraft can require extensive hardware modifications prior to weapon integration.

Currently, the Air Force has a few weapons that have a higher degree of integration complexity, but they are mostly on specialized aircraft, e.g., HARM on the F-4Gs and, recently, on limited numbers of F-16Cs. The Air Force is just starting to experience the complexity, and expense, of widespread integration of highly capable PGMs. Just as Figure 4 shows aircraft capability with the next generation PGMs, it also shows the degree and complexity of the integration task. Integration has become the proverbial "long pole in the tent" in fielding the next generation PGMs. The Air Force is mitigating the cost and schedule impacts by taking advantage of commonalities between JDAM, JSOW, and WCMD and work previously accomplished in the TSSAM program. However, OFP software code must be written, and testing must be done. All in all, great attention to detail is required to ensure that complex weapons development programs stay on track and in sync with their associated aircraft integration efforts.

Mission Planning

Just as the next generation GPS-aided PGMs are impacting aircraft capability and weapon integration, they are also forcing a fundamental change in the way the Air Force target plans air campaigns. To achieve high kill probabilities, the weapons require precise target coordinates. To fully realize the aim of an entire fleet of combat aircraft capable of launching large numbers of autonomously guided, accurate munitions, the Air Force must have a timely supply of accurate target coordinates.

In peacetime, a theater target list may be composed of generic targets, e.g., an installation or a facility, with a set of target reference coordinates. These coordinates generally equate to the center of mass for the installation or facility and are often not adequate for precise targeting. To plan a PGM strike, a targeteer would first determine the precise impact point that would satisfy the mission's objective. If the mission had not been previously planned, and theater resources, i.e., current data bases and the film-based Point Positioning Data Base (PPDB), were not adequate, these impact points would have to be generated by the Defense Mapping Agency (DMA) at its St. Louis facility. This is a manual process with limited throughput. When, in the near future, the Air Force has the capability to launch large numbers of highly accurate, GPS-aided PGMs from virtually every combat aircraft, there must be a timely supply of equally accurate target coordinates for specific aimpoints, e.g., the control tower of the airfield or the air shaft on the building. In a crisis, the demand for target coordinates could exceed the capability of targeteers to manually select aimpoints and the

DMA to produce them. This bottleneck could potentially impact mission success. However, there are both short- and long-term fixes for this problem.

In the short term, greater emphasis will be required on the update and maintenance of intelligence data bases, preplanning missions for known fixed targets, and the aggressive acquisition of automated targeting tools. The long-term solution is to develop mission planning capability at the unit level. This capability consists of two components. The first component is the DMA's Digital Point Positioning Data Base (DPPDB). Each DPPDB is a digitized variant of the existing film-based PPDB and contains data for a 60 nautical mile by 60 nautical mile geocell. The DMA will begin production of the DPPDB in CY95 with 50 geocells and ramp up to full production of 300 to 600 per year thereafter. The second component of the unit-level mission planning capability is the digital workstations to complete the planning process. The Combat Intelligence System (CIS) will be developed with embedded software to allow unit-level planners to manipulate the DPPDB and extract target coordinates. The Air Force Mission Support System (AFMSS) will take the target coordinates from CIS and complete the mission planning process by adding other mission data and storing the mission on the aircraft's data transfer cartridge. Together, the DPPDB, CIS, and AFMSS will compose a system that will allow unit-level mission planners to determine target coordinates to the accuracy required for GPS-aided PGMs and enable complete exploitation of their considerable capability.

GPS Vulnerability

Virtually every PGM currently undergoing development or in production will utilize GPS-aided INS guidance. In addition to the JDAM and JSOW, the Navy's Standoff Land Attack Missile (SLAM) and Tomahawk Block III and IV missiles, and the Army Tactical Missile System (ATACMS) will utilize this guidance means. Recently, there have been concerns raised in the technical community, and even in Congress, over the vulnerability of GPS to jamming. These concerns call into question the vulnerability of the next generation munitions themselves and the considerable investment being made in them.

The use of GPS-aided INS guidance on PGMs is indicative of the rapid proliferation of GPS throughout the DoD. Its worth was proven in Desert Storm when CALCM and other initial GPS-aided systems were especially successful. GPS has graduated from a force enhancer to a force multiplier. It provides a cheap, technologically simple autonomous guidance system for numerous systems in addition to PGMs. The combination is synergistic. GPS aids the INS by providing an absolute position reference to eliminate inherent INS drift. The INS aids the GPS by providing velocity information to aid signal acquisition and track.

GPS, like any broadcast radio signal, is vulnerable to jamming/interference. No system is absolutely immune. How then to address the vulnerability concerns? The first method involves campaign analysis–mission versus vulnerability. In planning a proper "high-low" mix of "silver bullet" and inventory fill munitions, the Air Force has analyzed the potential vulnerability of each weapon in light of the enemy defenses it would likely face. First-strike systems, those employed early in a campaign, have been designed with great resistance to hostile jamming. Munitions that will be employed throughout the latter stages of a war, after enemy electronic defenses have been rolled back, have been designed with less resistance, but are by no means tactically useless in the presence of jamming. These munitions contain an INS that is impervious to GPS jamming and may provide the required

accuracy required for target destruction. Mixing procurement of high-end and low-end GPS-aided munitions provides cost effective combat capability. The second method to address the vulnerability concerns is to take an electronic countermeasure/electronic counter-countermeasure perspective. As the next generation of systems starts to be fielded, adversaries may well be tempted to develop counters to them. As these counters are developed and fielded, the United States would then develop counters to them –countermove follows move.

The vulnerability concerns boil down to two questions:

- Do the next generation PGMs meet their mission requirements?
- Is the Air Force prepared to develop and field more robust systems if the threat dictates?

The answer to both of these questions is yes.

Acceleration of Capability

The great leverage the next generation of weapons will bring to the battlefield has generated significant interest in accelerating the fielding of these weapons, especially on the bomber fleet. To accomplish this acceleration, resources could be applied in three areas:

- Weapon development program
- Aircraft integration program
- Weapon procurement program.

Accelerating the development programs for these weapons is not feasible. Four programs–SFW, AGM-130, CALCM, and HAVE NAP–have completed development and are in production. One program, JSOW, is so far into development that acceleration is not possible. JDAM and WCMD are in early development and would appear to be acceleration candidates. However, they are not. JDAM, as one of the five DoD Pilot Programs, has already significantly streamlined its acquisition process. Additionally, JDAM has established cost as a technical requirement. To fulfill this requirement, the contractors are giving great early emphasis to manufacturability. If the Air Force attempted to accelerate JDAM, the contractors would have to forfeit this manufacturing emphasis in favor of schedule. The low-cost JDAM could be lost, which in turn would lower procurement quantities of this critical inventory fill weapon. WCMD is not a candidate for acceleration simply because the normal acquisition process has already been accelerated by revolutionary acquisition streamlining.

The other two means of acceleration, integration and procurement, must be considered together. Very simply, carriage capability without inventory provides no combat capability, and vice versa. Procurement acceleration is accomplished by increasing quantities or advancing the procurement decision points. If procurement quantities are increased, care must be given to a smooth production ramp and constant full-rate production. If procurement decision points are moved, risk is increased. While attention is required to ensure that risks do not become unacceptable, procurement acceleration is generally easier to accommodate within a program. Accelerating integration, as demonstrated above, is a far more complex

matter, especially when a weapon is integrated on multiple platforms. This is the limiting factor when balancing procurement and integration.

There are limited opportunities to accelerate capability by performing simultaneous integration of JDAM, JSOW, and WCMD by utilizing their interface commonality. This was recently funded for the F-16C and is possible on other aircraft. Basically, though, there are good matches between carriage capability and procurement as demonstrated in Figures 5, 6, and 7. In these figures, daily wartime carriage capability for each weapon is estimated on a year-by-year basis as aircraft integrations progress. Carriage capability is estimated by taking the total number of combat-coded aircraft programmed to be available when each aircraft completes integration times the number of weapons each aircraft carries times the average number of combat sorties expected per day. The key is to watch the start of the ramps and the initial slopes. As the figures show, there are good matches between production rampup and aircraft integration, indicating well-planned introduction. As the programs progress, carriage capability plateaus, while weapon inventories build to the numbers required to service the two-MRC target set.

Figure 5: JDAM Carriage Capability Versus Deliveries

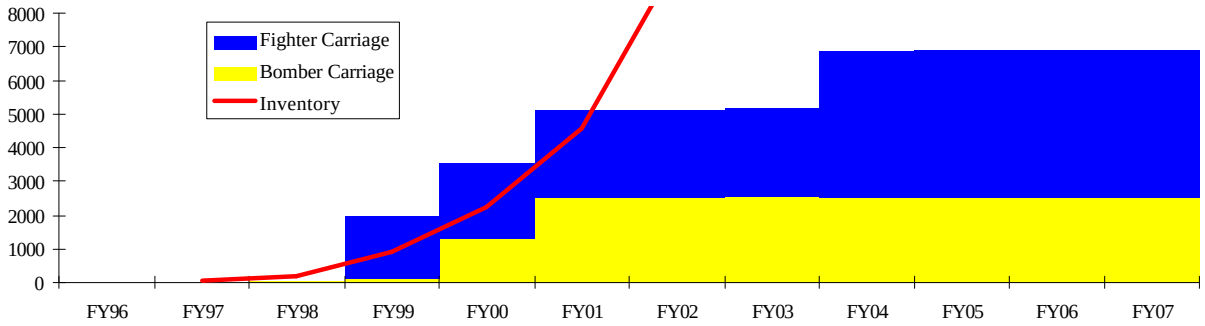


Figure 6: JSOW Carriage Capability Versus Deliveries

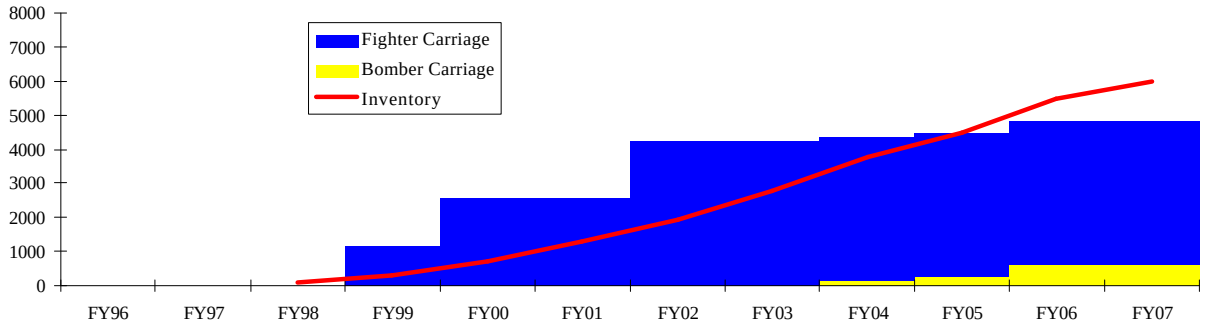
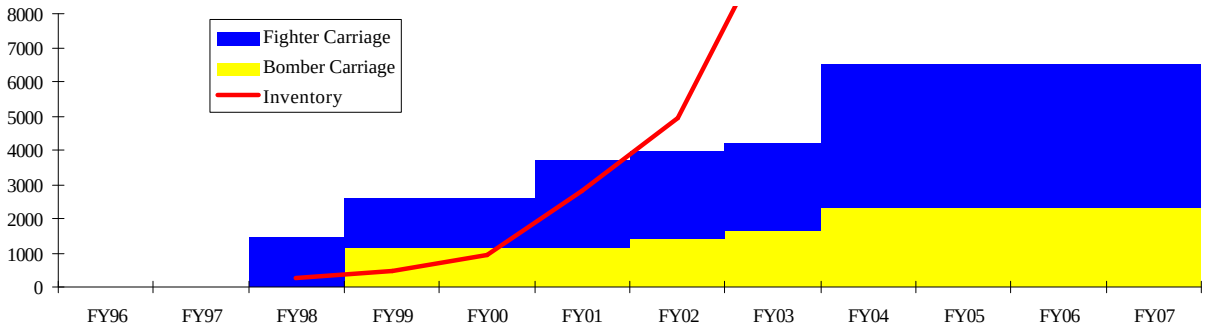


Figure 7: WCMD Carriage Capability Versus Deliveries

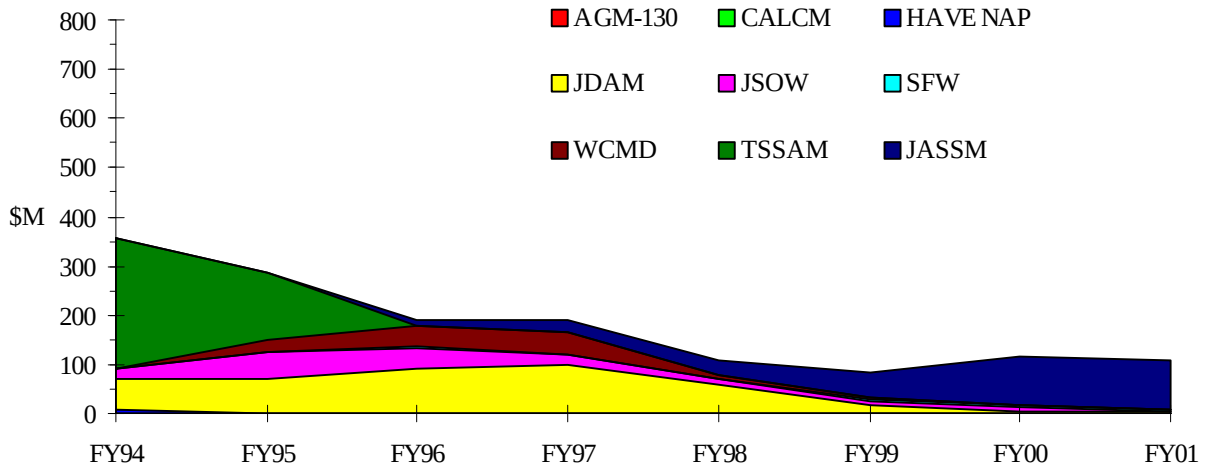


Munitions Funding

As discussed previously, the Air Force has gone 20-plus years without a revolutionary leap in weapons capability. In the same timeframe, the Air Force fielded the F-15, F-16, F-117, B-1, and B-2, which have provided quantum leaps in capability over their predecessors. The Air Force is now on the verge of making a similar quantum leap in weapons with the fielding of the next generation of PGMs.

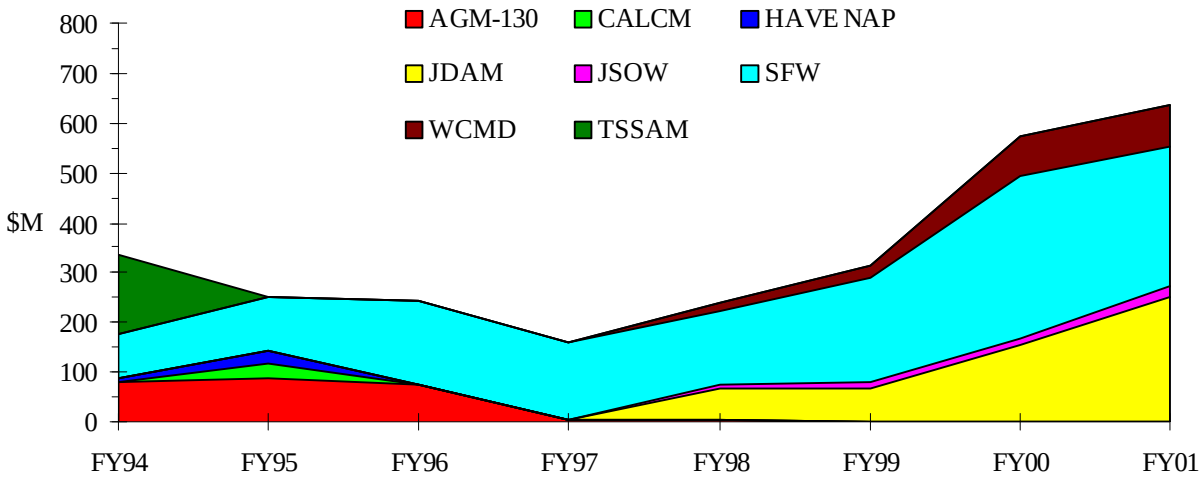
This leap is due to sustained, though somewhat cyclic, research, development, test, and evaluation (RDT&E) funding through the intervening years. As shown in Figure 8, over the next 6 years air-to-surface munitions RDT&E funding is programmed to fall from $352.3M in FY94 to $106.5M in FY01 as development programs complete and weapons enter production. This is to be expected when several programs complete development virtually simultaneously. In the future the weapons currently being developed and fielded will need preplanned product improvement (P^3I) programs, and the next revolutionary leap in capability will need development. The RDT&E funding lines can recover to support these currently undefined requirements. Attention to requirements development and funding profiles is required to ensure that the Air Force maintains its combat superiority.

Figure 8: Munitions RDT&E Funding



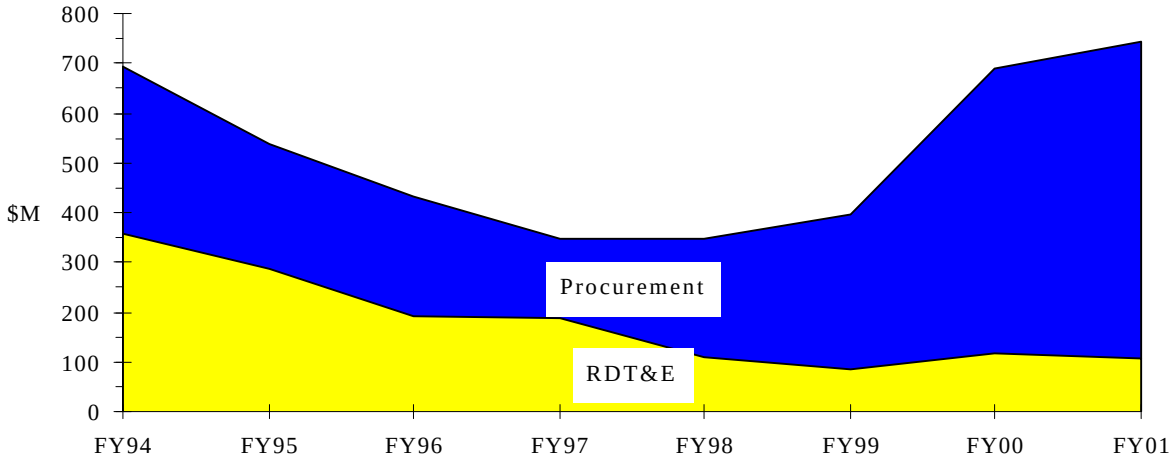
At the same time RDT&E funding is falling, the Air Force will reap the benefits of the prior years' substantial RDT&E effort with consecutive years of sustained procurement funding. Figure 9 demonstrates the Air Force's commitment to PGM, with procurement funding steadily increasing into the next century.

Figure 9: Munitions Procurement Funding



Perhaps a better demonstration of the Air Force's commitment to PGMs is demonstrated in Figure 10 with total, RDT&E and procurement, munitions funding. Despite the "bathtub" caused by the end of development programs and overall budget pressures, total munitions funding in FY01 will be approximately double that of the low point in FY97. The Air Force, along with OSD and Congress, must continue its support for this funding profile, especially in FY99 and beyond, in order to bring about the revolutionary change in weapon capability.

Figure 10: Total Munitions Funding



VISION FOR THE FUTURE

The development programs for the next generation weapons all end near FY00. The next question is "Where does the Air Force go from there? Of the multiple possibilities, one of the most promising area of investment appears to be in increasing the lethality of smaller weapons. Increasing weapon lethality per volume would have a twofold benefit. First of all, the large size of current weapons limits their carriage in the internal bays of the next generation of stealthy combat aircraft. For example, the F-22 weapons bay can only accept up to a 1,000-lb Mk-83-sized weapon. Studies have shown that the Mk-83 can service a portion of the two-MRC target set, and the Air Force is developing a 1,000-lb JDAM to utilize the inherent air-to-ground capabilities of the F-22 against that target set. However, studies have also shown that the 2000-lb variants of JDAM have the most utility across the target set. Therefore, portions of the target set cannot be serviced utilizing the unique characteristics of the F-22. Likewise, the next generation attack aircraft foreseen as the result of the Joint Advanced Strike Technology (JAST) program will have internal bays sized to accept 1,000-lb weapons as the primary weapon but will expand to allow use of 2,000-lb weapons in a low-observable configuration. Therefore, a 1,000-lb class weapon with the lethality of the current 2000-lb class would greatly increase the effectiveness of these future aircraft.

The second advantage is the multiplier effect smaller, more lethal weapons would have on current generation bombers and fighters. Again, equivalent lethality in a smaller package would make these existing aircraft even more effective. With the development of "smart" MIL-STD-1760-capable bomb racks, the sortie-by-sortie lethality of these aircraft could potentially be more than doubled. The areas of improvement to be leveraged for this capability are improved weapon casing design, more energetic explosives, and miniaturized electronics. While no specific development program has yet been initiated, laboratory work is ongoing in these areas. Overall, the goal of such an effort would be to develop significantly smaller weapons that would allow increased carriage, both internal and external, with lethality comparable to current warheads.

SUMMARY

The Air Force has a strategy for the considerable investment it is making in PGMs. The product of that strategy and investment is a revolutionary generation of weapons that will fundamentally change capabilities and warfighting. These weapons were developed via a requirements-based process. In turn, the requirements were, and new requirements will continue to be, driven by the changing and uncertain world threat environment, the changes within the Air Force due to the budget realities of the 1990s, and the limitations of the current inventory, which has not had revolutionary improvement in 25 years.

With the continuing need to support two major regional conflicts, it is imperative that each aircraft sortie be effective. The next generation of weapons will provide the force structure of tomorrow with an unprecedented ability to attack accurately at any time and survive the hostile environment. It is this capability that will provide the warfighters with the

flexibility needed to respond to an uncertain threat. This capability is not, however, strictly due to munitions improvements. It is the integration of these improved munitions on the entire fighter and bomber force and the development of improved targeting and mission planning capabilities that will bring their full capabilities to bear.